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Dated 20 January 2004

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Request for grant of a patent

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1.	Your reference	A10529GB-DJL/GMD/scf
2.	Patent application number *(The Patent Office will fill in this part)*	**0203640.8** 15 FEB 2002
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	Honeywell Normalair-Garrett (Holdings) Limited Yeovil Somerset BA20 2YD
	Patents ADP number *(if you know it)*	7937915002
	If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM
4.	Title of the invention	Life Support Systems for Aircraft
5.	Name of your agent *(if you have one)*	Forrester Ketley & Co.
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Chamberlain House Paradise Place Birmingham, B3 3HP.
	Patents ADP number *(if you know it)*	133005
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(day/month/year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	Yes

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Continuation sheets of this form	-
Description	7
Claim*(s)*	2
Abstract	-
Drawing*(s)*	1 only

10. If you are also filing any of the following, state how many against each item.

Priority documents	NONE
Translation of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	-
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent based on the basis of this application

Signature Forrester Ketley & Co.

Forrester Ketley & Co.

Date 15 February, 2002

12. Name and daytime telephone number of person to contact in the United Kingdom D J Lucking 0121 236 0484

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After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

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PATENTS ACT 1977

A10529GB

Title: Life Support Systems for Aircraft

Description of Invention

This invention relates a life support system for an aircraft, and to a method of operating the life support system.

Aircraft operating at high altitudes where the surrounding atmosphere does not provide a sufficient partial pressure of oxygen to maintain life have to be provided with means for furnishing air crew and any passengers with a breathable gas which is life-sustaining. In commercial aircraft this is achieved by providing a crew or passenger cabin which is pressurised, so that it is not necessary to provide a local oxygen supply to each passenger and crew member e.g. via a breathing mask. An emergency oxygen supply is made available for use if there should be a demand or an increased demand for oxygen or oxygen enriched gas, for example in the event that the cabin becomes de-pressurised. Such emergency oxygen supply has hitherto been provided from compressed gas storage containers and/or by chemical reaction, and is supplied to passengers and crew by individual breathing masks. The emergency oxygen supply is able to be maintained for sufficient time to enable the pilot to bring the aircraft down to a holding altitude at which the crew and passengers can again breathe atmospheric gases.

It has been proposed, for example in our published international patent application WO 02/04076, that oxygen or oxygen enriched gas for an aircraft emergency oxygen supply may be derived from an onboard oxygen generating system which is capable of supplying oxygen enriched gas indefinitely. The oxygen supply apparatus is preferably of the molecular sieve bed type which works by adsorbing non-oxygen gas from a pressurised gas supply, for example air bled from an engine compressor, fed to a bed of material such as zeolite. The gas emerging from the bed is oxygen-enriched, possibly up to 95% oxygen

under appropriate operating conditions. Two or more molecular sieve beds have to be utilised for indefinite maintenance of a supply of oxygen-enriched gas: while one or more beds are operating to oxygen-enrich the gas being passed therethrough, the other bed(s) is purged of the non-oxygen gas by being opened to low pressure atmosphere. By such alternate use of the beds, a continuous supply of the oxygen-enriched gas can be maintained.

Generally the construction and operation of molecular sieve bed type oxygen supply apparatus or generators, known as MSOGS, is well known and a detailed description of such MSOGS is not considered necessary for the understanding of the present invention. However there are other types of indefinitely-operable oxygen enriched gas supply apparatus, for example of the gas-permeable membrane type or the ceramic type.

International application WO 02/04076 also describes how main and auxiliary oxygen supply apparatus of the molecular sieve bed type may be used to supply product gas, which may be pure oxygen or oxygen enriched gas, to a breathing gas supply apparatus in such a way that the product gas is immediately available for breathing, in the event of an emergency cabin decompression, enabling the pilot of the aircraft safely to reduce height to one at which the aircraft may continue to be flown while its occupants continue to breath the product gas. A small supply of oxygen e.g. in pressurised containers may still be necessary to provide breathing gas immediately on decompression until the MSOGS oxygen supply apparatus is brought on line. In any event, once the MSOGS apparatus has been brought on line the aircraft may continue to be flown at a holding altitude possibly of about 20,000 ft while the passengers are supplied with breathing gas from the life support system, which is much higher than the altitude at which the aircraft would have to continue to fly if there were no oxygen supply apparatus capable of operating indefinitely.

However it remains the case that most commercial aircraft have an emergency oxygen supply which is intended to operate from a stored supply of

compressed pure or substantially pure oxygen, to be delivered only for the time necessary for the aircraft to descend to a relatively low safe holding altitude. It would be desirable if one could connect an indefinitely-operable oxygen generation system, for example a MSOGS, to a conventional emergency oxygen supply system to enable the aircraft to be flown at a higher holding altitude, without requiring any substantial modifications to the existing emergency oxygen system. However this would entail the provision of a MSOGS of high capacity to deliver oxygen enriched gas at an oxygen concentration comparable with that provided from compressed storage containers, which would be heavy and bulky which are undesirable characteristics in aircraft. Although a MSOGS is capable of supply oxygen-enriched gas at an oxygen concentration up to about 95% O^2, a very large MSOGS would be necessary to achieve this for the quantity of breathing gas demanded by an aircraft carrying a large number of passengers as well as its crew. It is broadly the object of the present invention to provide for supply of oxygen enriched gas by MSOGS in such a way that such undesirable effects can be ameliorated.

According to one aspect of the present invention, we provide a life support system for an aircraft, including a first oxygen supply apparatus operable to supply product gas, which may be pure oxygen or oxygen-enriched gas, to a breathing gas supply apparatus, and a second oxygen supply apparatus operable to supply a product gas which is an oxygen-enriched gas containing a lower concentration of oxygen than that in the first product gas, wherein the second product gas is supplied at a pressure which is higher than that at which said first product gas is supplied to the breathing gas supply apparatus.

The first oxygen supply apparatus preferably comprises one or more pressurised containers storing the first product gas, or providing it by chemical reaction, whilst the second oxygen supply apparatus preferably is an oxygen supply apparatus of the molecular sieve type.

The present invention is based on the concept that the performance of an MSOGS may be optimised, in relation to its weight, bulk and so on, if it is operated in such a way as to provide oxygen-enriched product gas at less than the maximum degree of oxygen enrichment of which it is capable, but if it provides such a product gas to a breathing gas supply apparatus at a higher pressure than would be used for the supply of a more highly-enriched product gas, the effectiveness in terms of keeping the aircraft occupants supplied with breathing gas can be maintained. In other words, the supply of the second product gas to the breathing gas supply apparatus at a lower oxygen concentration but higher pressure enables a smaller and lighter MSOGS to be used.

The breathing gas supply apparatus usually comprises one or more breathing gas supply lines leading to individual breathing masks. Each breathing mask may be connected to its supply line by way of an orifice, which effectively controls the oxygen mass fraction reaching the mask. If pressure in the supply line is increased, flow to the mask through the orifice increases so that the same or substantially the same oxygen mass fraction can be achieved at the mask as when the gas in the supply line is at a lower pressure but higher oxygen concentration.

Thus the invention enables the conventional emergency oxygen supply in a commercial aircraft to be adapted to be supplied with oxygen-enriched gas indefinitely to enable the aircraft to be flown, in the event of cabin de-pressurisation, at a higher holding altitude. All that is necessary is for the second oxygen supply apparatus, preferably a MSOGS, to be connected to the breathing gas supply line(s) leading to the breathing masks, the second oxygen supply apparatus, providing its product gas at a higher pressure than that at which the breathing gas supply line(s) is supplied from the first oxygen supply apparatus (namely the pressurised containers of oxygen or possibly the chemical reaction oxygen generator(s)).

The invention also provides a method of operating a life support system for an aircraft, comprising operating a first oxygen supply apparatus to supply a product gas, which may be pure oxygen or oxygen enriched gas, to a breathing gas supply apparatus, and operating a second oxygen supply apparatus to supply a second product gas which is an oxygen enriched gas containing a lower concentration of oxygen than that of that in the first product gas, wherein the second oxygen supply apparatus is operated to supply the second product gas at a pressure higher than that at which the first product gas is supplied to the breathing gas supply apparatus.

Preferably, in the event of an emergency requirement for operation of the life support system, the first oxygen supply apparatus immediately operates and subsequently the second oxygen supply apparatus is operated.

The accompanying drawing shows diagrammatically the use of the present invention. In the drawing, pressurised storage containers for a first product gas which may be pure oxygen or nearly pure oxygen are indicated at 10. This first oxygen supply apparatus delivers its gas by way of a flow control valve 11 to one or more breathing gas supply lines as indicated at 12. A number of breathing masks 13 are fed from the supply line 12, by way of respective orifices 14 which control the flow rate to the masks in such a way that when they are used a suitable life-sustaining oxygen concentration is maintained at the masks. The size of the orifices is selected so that the required oxygen concentration is maintained at the masks, consistent with the pressure which is maintained in the line 12.

The masks are deployed and oxygen supplied thereto in the event of sudden loss of aircraft cabin pressure. Usually the amount of oxygen stored at 10 is sufficient to maintain the supply to the masks for the length of time it takes the pilot of the aircraft to bring it down to a holding altitude at which the passengers and crew can continue to breath the ambient atmosphere, until the pilot can land the aircraft.

In accordance with the invention, a second oxygen supply apparatus 15 is provided which preferably is a molecular sieve oxygen generating system (MSOGS) fed with compressed gas (air) at 16 from an engine compressor. Whilst theoretically a MSOGS is capable of providing at its outlet 17 an oxygen - enriched gas of up to about 95% oxygen, a MSOGS of reasonable size and weight for fitting in a commercial aircraft may be arranged and operated in such a way as to deliver a product gas which is around 80% oxygen. By way of a valve 18, this product gas is delivered to the line 12 at a Tee piece 19 and this gas is delivered at a pressure which is higher than that at which gas is supplied to the line 12 from the stored oxygen supply 10.

Under these conditions, a higher flow rate of gas is delivered to the masks 13 through the orifices 14, the result being that although the gas in the line 12 contains a lower concentration of oxygen than that which it contains when it is being supplied from the supply apparatus 10, the effective delivery of oxygen to the masks 13 can be the same or more or less the same as when the gas is derived from the supply 10.

Since the MSOGS is capable of supplying its oxygen-enriched product gas indefinitely, the masks can be continued to be used by the aircraft's occupants with the result that the aircraft can continue to fly at a holding altitude substantially higher than that at which it would have to fly if use of the masks had to be discontinued when the supply 10 of oxygen has run out. At the same time, the selection of a size and weight of MSOGS of which can be operated to supply its product gas at an oxygen concentration of e.g. 80%, i.e. less than its theoretical maximum product gas oxygen concentration, means that optimisation of the size of the MSOGS can be achieved.

In the present specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in

terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A life support system for an aircraft, including a first oxygen supply apparatus operable to supply product gas, which may be pure oxygen or oxygen-enriched gas, to a breathing gas supply apparatus, and a second oxygen supply apparatus operable to supply a product gas which is an oxygen-enriched gas containing a lower concentration of oxygen than that in the first product gas, wherein the second product gas is supplied at a pressure which is higher than that at which the first product gas is supplied to the breathing gas supply apparatus.

2. A life support system according to Claim 1 wherein the first oxygen supply apparatus comprises one or more pressurised containers storing said first product gas.

3. A life support system according to Claim 1 or Claim 2 wherein the second oxygen supply apparatus is of the molecular sieve type.

4. A life support system according to any one of the preceding Claims, wherein the breathing gas supply apparatus comprises at least one breathing gas supply line leading to at least one breathing mask by way of a respective orifice.

5. A method of operating a life support system for an aircraft, comprising operating a first oxygen supply apparatus to supply a product gas, which may be pure oxygen or oxygen enriched gas, to a breathing gas supply apparatus, and operating a second oxygen supply apparatus to supply a second product gas which is an oxygen enriched gas containing a lower concentration of oxygen than that of that in the first product gas, wherein the second oxygen supply apparatus us operated to supply the second product gas at a pressure higher than that at which the first product gas is supplied to the breathing gas supply apparatus.

6. A method according to claim 5 wherein, in the event of an emergency requirement for operation of the life support system, the first oxygen supply apparatus operates first and subsequently the second oxygen supply apparatus is operated.

7. A life support system, or method of operating same , substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

8. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

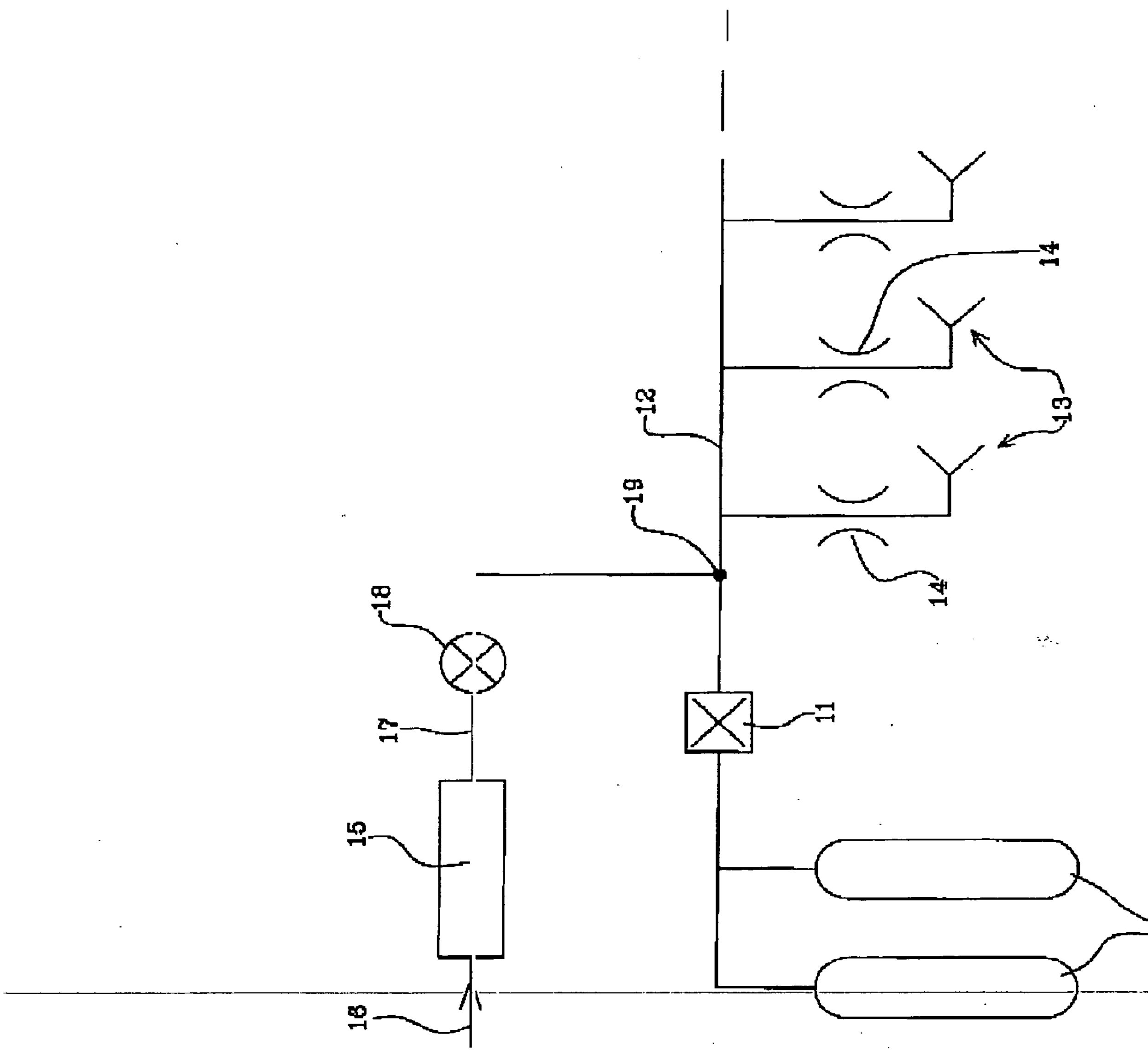

FIG. 1

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